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# United States Patent [19]

George, II et al.

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[54] **ABSORPTION REFRIGERATION SYSTEM BURNER AND GENERATOR ASSEMBLY**

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[73] Assignee: **Gas Research Institute**, Chicago, Ill.

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[51] **Int. Cl.**[5] ..... **F25B 15/00**

[52] **U.S. Cl.** ..... **62/476**; 122/14; 122/19

[58] **Field of Search** ..... 62/476; 122/14, 17, 122/18, 19; 110/244, 243

[56] **References Cited**

U.S. PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| 3,526,211 | 9/1970 | Corey | 122/14 |
| 4,926,659 | 5/1990 | Christensen | 62/476 |

FOREIGN PATENT DOCUMENTS

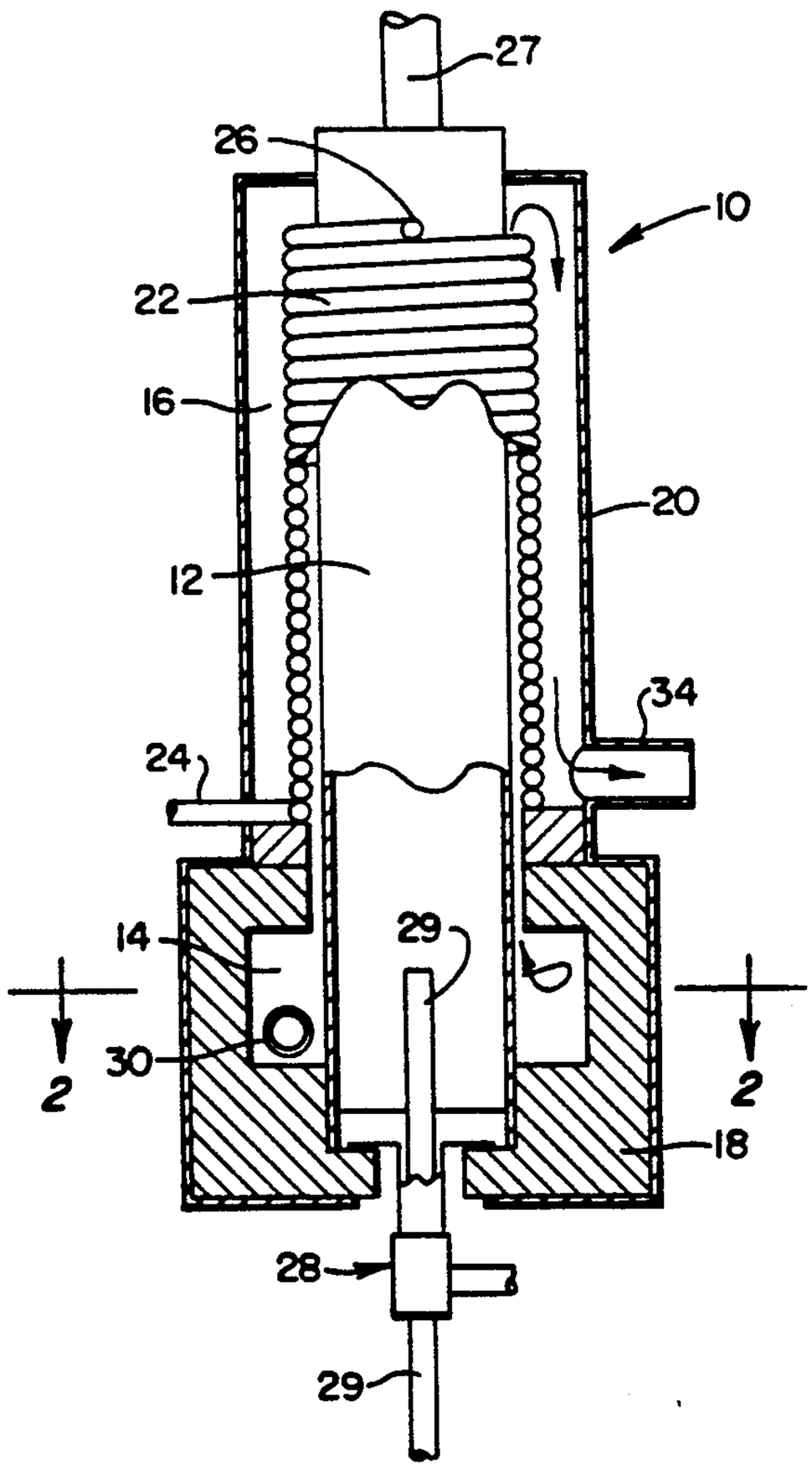
| | | | |
|---|---|---|---|
| 0256043 | 8/1926 | United Kingdom | 122/19 |

*Primary Examiner*—John M. Sollecito
*Attorney, Agent, or Firm*—Watkins, Dunbar & Pollick

[57] **ABSTRACT**

An absorption refrigeration system generator assembly is provided with a centrally positioned, generally vertical boiling pot element having a lower portion and an upper portion, with an annular primary combustion chamber surrounding the boiling pot element lower portion exclusive of the boiling pot member bottom surface, and with an optional contiguous secondary combustion chamber surrounding the boiling pot element upper portion. An included fuel/gas air supply and ignitor cooperates with the primary combustion chamber and causes combustion products to swirl over the lower and upper portions of the boiling pot element.

**6 Claims, 2 Drawing Sheets**



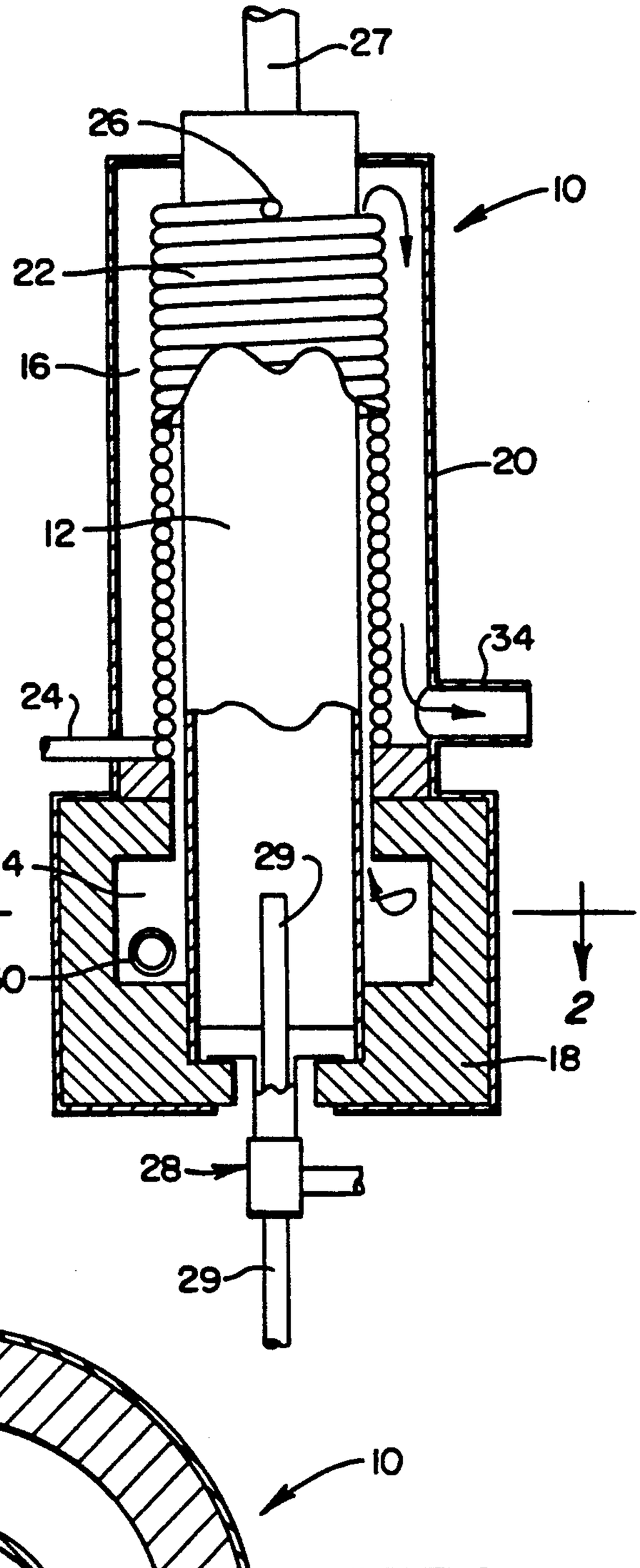

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FIG. 1

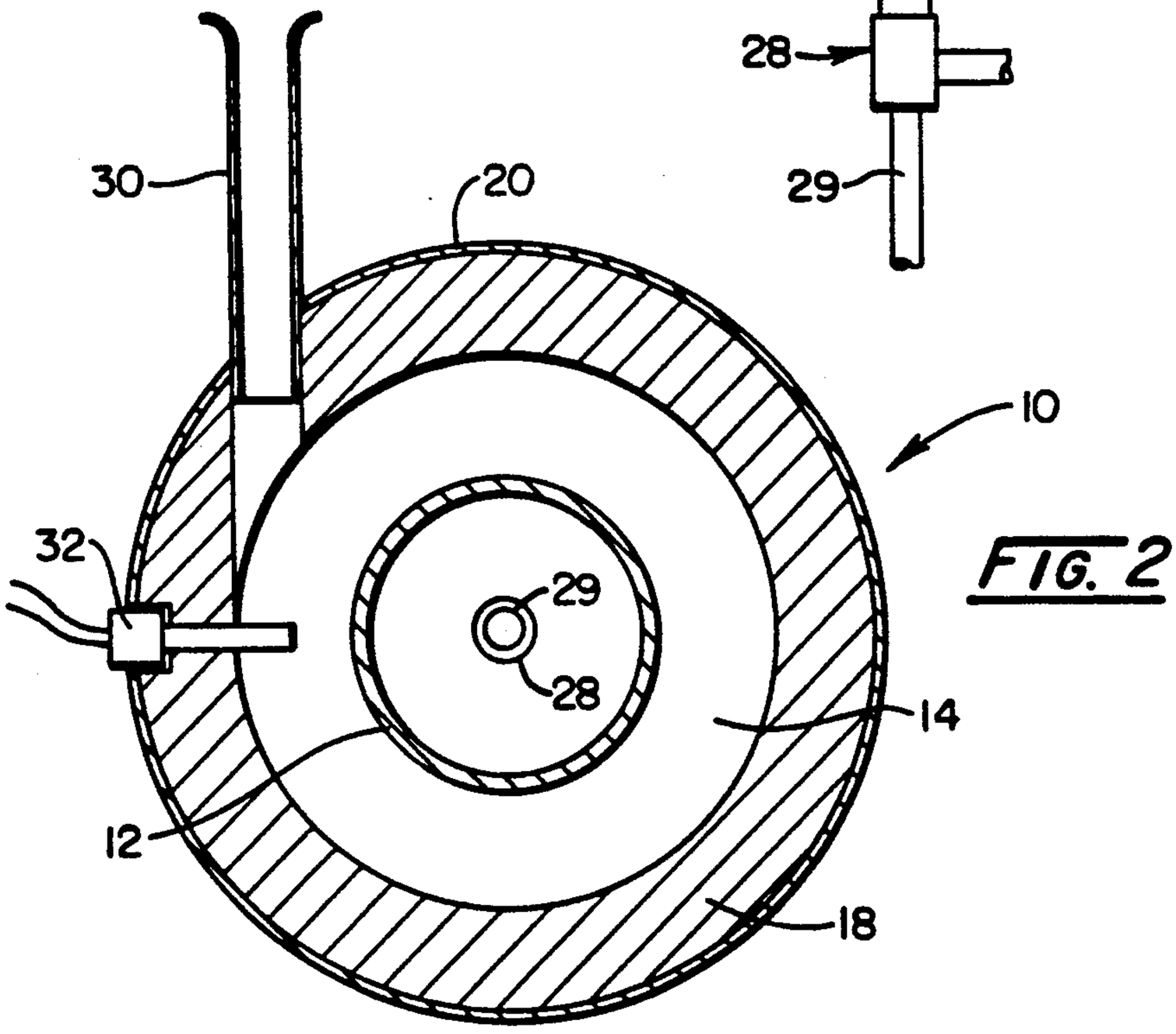
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FIG. 2

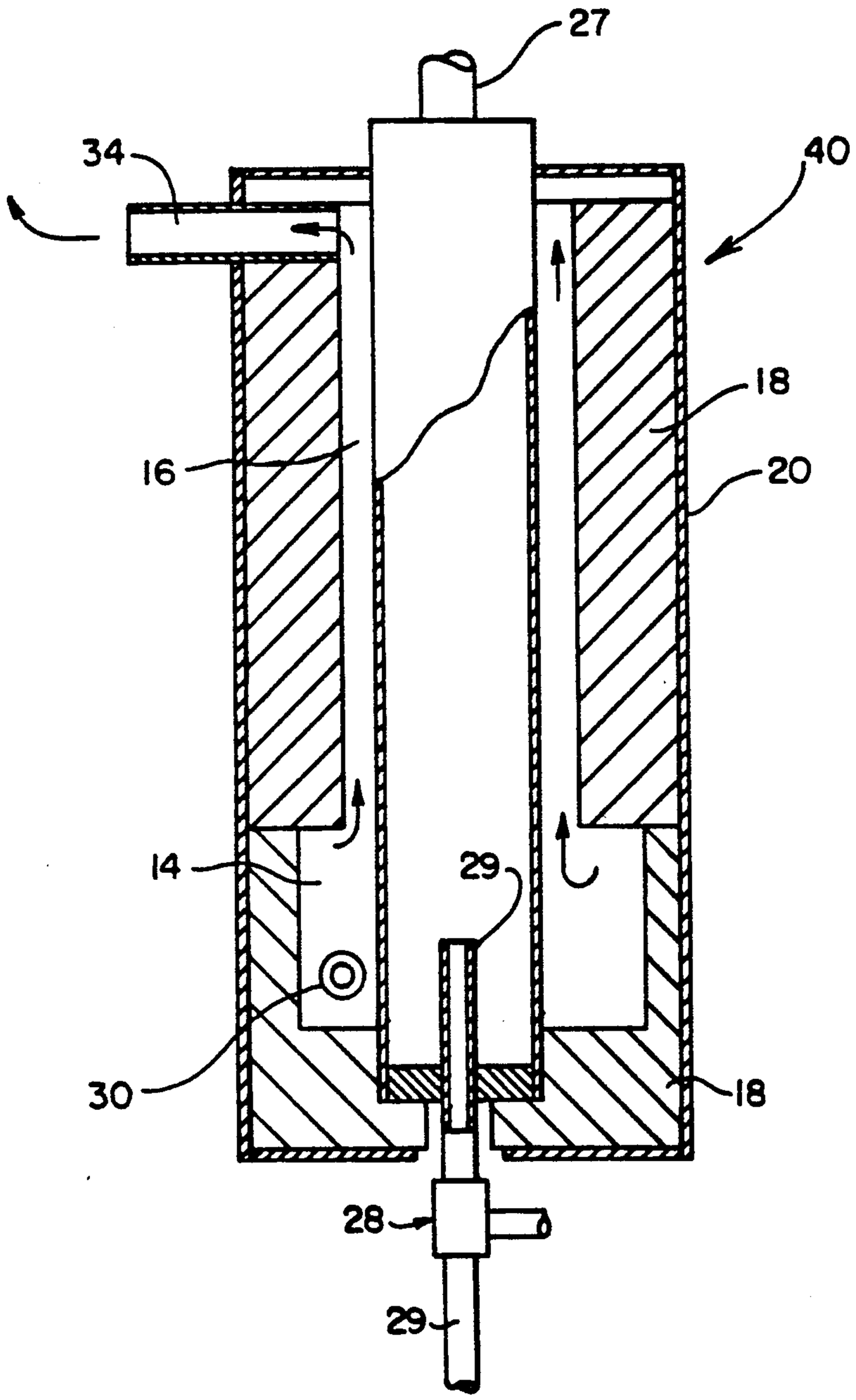


FIG. 3

# ABSORPTION REFRIGERATION SYSTEM BURNER AND GENERATOR ASSEMBLY

## FIELD OF THE INVENTION

This invention relates generally to absorption refrigeration systems, and particularly concerns an improved burner and generator assembly which functions to increase the liquid flow and thermal efficiencies with which absorption refrigeration system refrigerant, usually water, is separated from a dilute absorption refrigeration system refrigeration liquid solution, usually lithium bromide and water, to obtain a relatively concentrated absorption refrigeration system refrigerant solution. Also, the burner and generator combination is considered useful in applications other than in an absorption refrigeration system.

## BACKGROUND OF THE INVENTION

Numerous different types of generator assemblies for application to absorption refrigeration systems are known including generator assemblies which are powered by natural gas or other types of gaseous fuel. See, for instance, U.S. Pat. No. 4,926,659 issued in the name of Christensen, et al. Also, the use of cyclone-type burner assemblies in a variety of applications are well known. Representative known cyclone-type burner assemblies include those disclosed in U.S. Pat. No. 4,687,436 issued in the name of Shigeta for a distillation device, U.S. Pat. No. 4,351,251 issued in the name of Brashears for a drying kiln, U.S. Pat. No. 3,885,906 issued in the name of Shurygin et al. for incinerating fluid industrial waste, U.S. Pat. No. 3,459,414 issued in the name of Schmidt for heat-treating metal ingots or billets, U.S. Pat. No. 2,486,018 issued in the name of Furkert for melting metal, and U.S. Pat. No. 1,672,084 issued in the name of Press for domestic furnaces.

We have discovered that a cyclone-type burner may be advantageously combined with an absorption refrigeration system generator, particularly a generator having a generally vertical, boiling pot element with a high length to diameter aspect ratio, to prevent a "slugging" action which would otherwise occur and which impedes the flow of concentrated refrigerant solution from the generator assembly to the system absorber component. Also, we have further discovered that, when properly integrated with the system boiling pot element and cyclone burner combination, a novel dilute solution preheater element will further improve the thermal efficiency of separating refrigerant from dilute refrigeration solution for subsequent condensation apart from the system generator assembly.

Still other advantages of the invention will become apparent from a careful consideration of the specification and drawings which follow.

## SUMMARY OF THE INVENTION

The generator assembly of this invention comprises a generally vertical, cylindrical, boiling pot element **12** which is surrounded at its lower extremities, but not at its bottom surface, by an annular primary combustion chamber **14** further surrounded by refractory **18** and at its upper extremities by an annular secondary combustion chamber element **16** comprising an extension of the primary combustion chamber element **14**. In one configuration of the invention, the secondary combustion chamber **16** further includes a preheater coil element **22**. In an alternate embodiment, and because the preheater coil element is omitted, the annular secondary combustion element is also surrounded by refractory.



A dilute refrigeration solution inlet **24** cooperates with the lower extreme of the preheater coil element; a concentrated solution outlet **29** cooperates with the boiling pot element lower extremity. A flow of fuel gas and air is introduced tangentially into the primary combustion chamber and ignited. The ignited mixture swirls about chamber **14**, heats the surface of surrounding refractory **18**, and transfers heat by direct contact with pot element **12**. The refractory surface heated by the ignited mixture radiates and also provides heat to pot element **12**. After leaving chamber **14**, the combustion mixture continues swirling upwardly into the annular second combustion chamber for continuing combustion. Such continuing combustion provides heat by convection and radiation into both the surrounding preheater coil and the interior boiling pot element upper extremity. Dilute refrigeration solution heated in the preheater coil is flowed from the preheater coil into the boiling pot element near its upper extremity. The flue gas generated by fuel gas combustion is swirled upwardly over the preheater coil inner surfaces and downwardly over the preheater coil outer surfaces to a generator assembly exhaust outlet located generally midway between the assembly upper and lower extremes. Additional details regarding the generator assembly of this invention are best obtained from a consideration of the detailed description and drawings which follow.

## DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic elevational view, partially in section, of a preferred embodiment of the absorption refrigeration system generator assembly of this invention.

FIG. **2** is a sectional view taken at line **2**—**2** of FIG. **1**.

FIG. **3** is a sectional view, similar to FIG. **1**, but of an alternate embodiment of the invention.

## DETAILED DESCRIPTION

FIG. **1** illustrates, schematically and partially in section, an elevational view of a preferred embodiment **10** of the absorption refrigeration system generator assembly of this invention. Assembly **10** basically comprises a centrally situated and generally vertically oriented solution boiling pot element **12** surrounded in its lower extreme by a generally annular primary combustion chamber **14** and in its upper extreme also by a generally annular secondary combustion chamber **16** which is contiguous to chamber **14**. Chamber **14** is in turn surrounded by a conventional insulating refractory **18**. A housing element **20**, preferably formed of metal, surrounds and substantially contains elements **12** through **18**.

Assembly **10** in the FIGS. **1** and **2** embodiment also is comprised of a generally annular fluid-to-fluid heat exchanger element **22** which preferably is configured as a closely coiled metallic tube. Such heat exchanger is advantageous for some applications of the invention but is not necessary in every instance. Heat exchanger **22** has an inlet **24** that receives relatively dilute absorption refrigeration system refrigerant solution from the refrigeration system evaporator element. Fluid flowed from inlet **24** and through coil **22** is flowed through a heat exchanger outlet **26** and into the interior of boiling pot **12** near the upper extreme of element **12**.

Also, it is preferred that heat exchanger **22** be properly sized so that when positioned in secondary combustion chamber **16** its inner undulating, generally cylindrical surface is spaced apart from the outer cylindrical surface of boiling pot element **12** and its outer undulating, generally cylindrical surface is spaced apart from the inner surface of housing **20**. Boiling pot element **12** is provided with an outlet **27** that flows refrigerant vapor (steam) from the pot interior to the refrigeration system condenser element (not shown). Boiling pot element **12** also is provided with an outlet **29** in its lower extreme that flows relatively concentrated refrigeration system refrigeration solution from the pot lower interior region to the refrigeration system evaporator/absorber element (also not shown). Further, it is generally preferred to provide assembly with a selectively operable (valved) drain **28** at the boiling pot element lower extreme for use in removing refrigeration solution and/or unwanted sediments from the assembly as necessary. Whereas the use of preheater coil is advantageous in some instances, it is not a necessary element in all applications of the invention.

As shown in FIG. **2**, assembly **10** is also comprised of fuel gas/air inlet **30** that is positioned generally tangentially relative to the outer surface of annular primary combustion chamber **14**. Lastly, a suitable conventional and selectively operable electrical ignition device **32** is located to project into chamber **14** in the path of fuel gas/air mixtures flowed through inlet **30**.

During operation of generator assembly **10**, the fuel gas/air mixture ignited by element **32** swirls spirally within primary combustion chamber **14** and its heat of combustion is partially transferred to the lower interior extreme of boiling pot element **12** to cause a boiling of any solution there present without "slugging", and also is radiated and partially transferred into refractory **18**. The ignited mixture afterwards continues its combustion and spiral flow into secondary combustion chamber **16** in the region between the outer surface of boiling pot element **12** and the inner surface of annular heat exchanger element **22** to cause a further heating of refrigeration solution in the interior of boiling pot **12** and also a preliminary heating of refrigeration solution being flowed through heat exchanger **22**. The residual gases from the combustion afterwards pass over the top turn of heat exchanger **22** and are flowed generally downwardly in that annular portion of secondary combustion chamber **16** which is situated between the outer surface of heat exchanger **22** and the adjacent inner surface of housing **20** to exhaust outlet **34** causing a still further preliminary heating of refrigeration solution being flowed through heat exchanger **22** to the interior of boiling pot element **12**.

FIG. **3** is provided in the drawings to illustrate the alternate embodiment of the invention assembly not having a preheater coil element **22**. The secondary combustion chamber **16** is encircled by additional refractory in lieu of containing the otherwise included preheater coil element.

It is herein understood that although the present invention has been specifically disclosed with the preferred embodiments and examples, modifications and variation of the concepts herein disclosed may be resorted to by those skilled in the art. Such modifications and variations are considered to be within the scope of the invention and the appended claims.

We claim:



**1**. An absorption refrigeration system burner and generator assembly comprising:

a) a centrally positioned and vertically oriented boiling pot member having a generally uninsulated lower portion but with an insulated bottom and an uninsulated upper portion;

b) a generally annular and insulated primary combustion chamber means surrounding said boiling pot means surrounding said boiling pot means uninsulated lower portion;

c) a generally annular enclosed secondary combustion chamber means surrounding said boiling pot means upper portion in contiguous relation to said primary combustion chamber means;

d) refrigeration solution preheater means situated in said secondary combustion chamber means in a surrounding and spaced-apart relationship to said boiling pot means upper portion;

e) fuel gas/air supply and ignitor means cooperating with said primary combustion chamber means; and

f) outlet means positioned generally centrally in said boiling pot means uninsulated lower portion insulated bottom to flow relatively concentrated refrigeration solution from within said boiling pot means without periodic slugging,

said fuel gas/air supply and ignitor means being positioned and oriented to cause fuel gas/air mixtures supplied to said primary combustion chamber and ignited to combust along a spiral path which surrounds said boiling pot means lower portion and which passes in said secondary combustion chamber means between said refrigeration solution preheater means and said boiling pot means upper portion.

**2**. The assembly defined by claim **1** wherein said refrigeration solution preheater means is a closely-coiled metallic tube means having an undulating exterior surface spaced apart from and opposing the exterior surface of said boiling pot means upper portion.

**3**. The assembly defined by claim **1** and further comprising an exhaust outlet cooperating with said secondary combustion chamber means at a region adjacent the lower extreme of said refrigeration solution preheater means, said exhaust outlet receiving combustion product gases flowed upwardly between said preheater means and said boiling pot means upper portion and afterwards flowed downwardly over an outer surface of said preheater means away from said boiling pot means upper portion.

**4**. The assembly defined by claim **1** wherein said primary combustion chamber means is insulated by a refractory composition.

**5**. An absorption refrigeration system burner and generator assembly comprising:

a) a centrally positioned and vertically oriented boiling pot means of high aspect ratio having an insulated bottom surface;

b) a generally annular and insulated primary combustion chamber means surrounding said boiling pot means lower portion exclusive of the bottom surface of the boiling pot means;

c) a generally annular enclosed secondary combustion chamber means surrounding said boiling pot means upper portion in contiguous relation to said primary combustion chamber means;

d) fuel gas/air supply and ignitor means cooperating with said primary combustion chamber means; and

e) outlet means positioned generally centrally in said boiling pot means insulated bottom surface to flow

relatively concentrated refrigeration solution from within said boiling pot means without periodic slugging,

said fuel gas/air supply ignitor means being positioned and oriented to cause fuel gas/air mixtures supplied to said primary combustion chamber and ignited to combust along a spiral path which surrounds said boiling pot means lower portion and which passes through said secondary combustion chamber means.



6. The assembly defined by claim 5 wherein said primary combustion chamber means is insulated by a refractory composition.

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UNITED STATES PATENT AND TRADEMARK OFFICE

# CERTIFICATE OF CORRECTION

PATENT NO. : 5,230,225

DATED : July 27, 1993

INVENTOR(S) : George II, et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 4, lines 8-9, after "surrounding said boiling pot means", delete "surrounding said boiling pot means".

Signed and Sealed this

Eighth Day of March, 1994

*Attest:*

BRUCE LEHMAN

*Attesting Officer*

*Commissioner of Patents and Trademarks*